NERRS Science Collaborative Progress Report for the Period March 1, 2013 through August 31, 2013

Our Coast–Our Future: Planning for Sea Level Rise and Storm Hazards in the San Francisco Bay Area

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Contributing team members and their role in the project: Patrick Barnard (applied science PI), Grant Ballard (applied science PI), Megan Elrod (outreach support), Michael Fitzgibbon (lead engineer), Kelley Higgason (project coordinator), Sara Hutto (project support) Sherie Michaile (informatics engineer), Doug Moody, (informatics engineer), Marina Psaros (collaboration lead), Sam Veloz (spatial ecologist), Julian Wood (collaboration liaison)

A. Progress overview: State the overall goal of your project, and briefly summarize in one or two paragraphs, what you planned to accomplish during this period and your progress on tasks for this reporting period. This overview will be made public for all reports, including confidential submissions.

The ultimate goal of the Our Coast–Our Future (OCOF) project is to provide the tools and information needed for local decision-makers to utilize the best available science to inform the development of climate change adaptation strategies, and take actions to ensure healthy, viable, and sustainable coastal ecosystems and communities. We plan to accomplish this goal by producing science-based, online decision-support tools to help local decision makers plan for and respond to sea level rise and storm hazards along the San Francisco Bay shoreline. The support tools are being built in collaboration with end users. A fine scale resolution (2 meter) Digital Elevation Model for San Francisco Bay, and localized extreme storm and sea level rise scenarios are currently being developed to underlie the tool. This project builds on a related effort already underway on the North-central California outer coast (referred to hereafter as "Outer Coast"), and the resulting tools will ultimately be available for the shoreline of the entire 9-county San Francisco Bay Area, with the Outer Coast portion made publically available in February 2013.

During this reporting period, the team has: held two training webinars for the Outer Coast tools; held 3 project team meetings; held 1 meeting with the project Advisory Committee; partnered on a proposal with Marin County to provide technical assistance for a sea level rise vulnerability assessment and adaptation plan for the county; held a directed training and discussion on the local applicability of the OCOF tools with State Coastal Conservancy staff; provided 6 demonstrations of the Outer Coast online tools; further developed the technical assistance program to best meet the needs of end users, including holding planning calls with Advisory Committee members to identify technical assistance projects; completed the Digital Elevation Model (DEM) for the entire San Francisco Bay Area; strategized the use of fluvial data, wind data, wave data, SLR-based tidal amplification, and vertical land motion for the San Francisco Bay model; continued to synthesize and process feedback received from stakeholders; presented the project at several professional conferences and meetings; and interfaced with expert peers.

B. Working with Intended Users:

Describe the progress on tasks related to the integration of intended users into the project for this reporting period.

During this reporting period, the team held one formal and several informal information exchanges with the OCOF Advisory Committee (our main vehicle for intended user collaboration) as a group and individually. During the April 2013 Advisory Committee meeting, a draft list of nested grids, or areas of high resolution, for the San Francisco Bay model was discussed. This list was created through a collaborative process during which OCOF staff and Advisory Committee members developed the following selection criteria: partner interest; hydrologic complexity; moderate amount of vertical slope variability; complex shorelines, with multiple shoreline types; economic significance (either an at-risk area that lacks the resources to conduct own vulnerability assessment, and/or an at-risk area that includes economically-important resources); other similar studies are not planned or already underway; may already experience frequent flooding, such as river mouths or portions of the Bay Trail; project or planning process that requires vulnerability assessment will take place in the next 2 – 7 years, the approximate time during which the existing OCOF model and tool will be the state-of-the-science for our region.

Whereas most of the Bay model will make explicit predictions every few hundred meters, in areas with nested grids, projections are made on an approximate ~20 meter scale. USGS is working to incorporate identified sites of interest by grouping them into 12 sites of up to 10 km in size. These sites include (Figure 1):

- Coyote Creek / Alviso
- Foster City
- Corte Madera
- Highway 37
- Petaluma River
- Richardson Bay near 101, Tam Junction, Marin City
- East Palo Alto
- Embarcadero, near Howard, ballpark – Pier 54/Mission Bay
- Hayward shoreline / Oakland airport
- Napa River estuary
- Ravenswood / Dunbarton Bridge
- Richmond

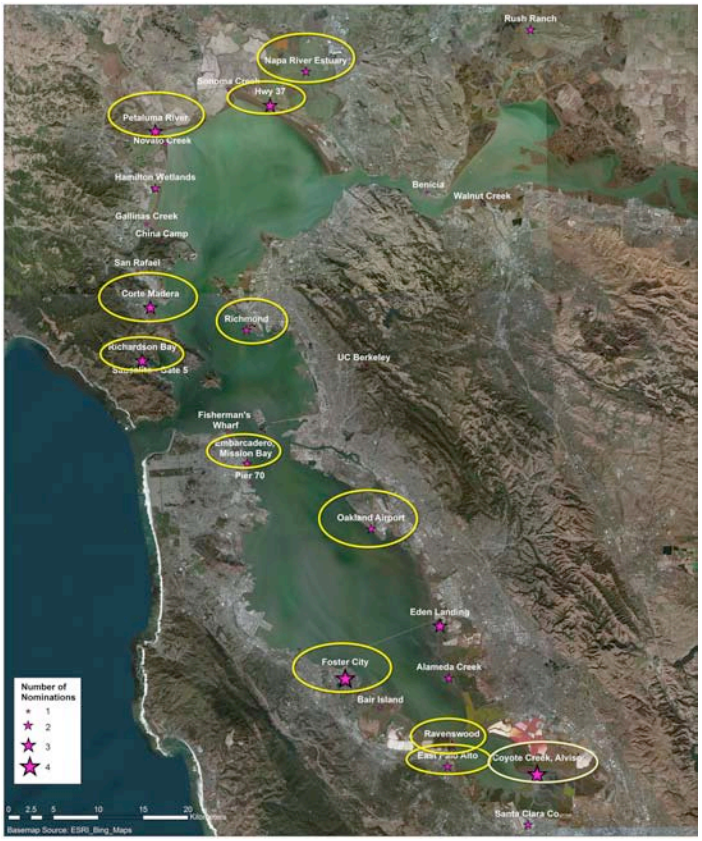

Figure 1. Regions within San Francisco Bay where high – resolution grids (~20m) are being developed. Starred sites nominated by the OCOF Advisory Committee; yellow circled sites are those that are being incorporated on a high-resolution scale into the model.

In addition to one formal Advisory Committee meeting, numerous planning calls were organized with Advisory Committee members and other partners to explore the preferred ways of conducting directed trainings and technical assistance to best meet the needs of our end users, as well as identify potential technical assistance projects. The current list of potential projects includes: Marin County Sea Level Rise Study (partnered on submitted proposal); Silicon Valley 2.0 (holding a series of exploratory calls); South Bay Salt Pond Restoration Project (attended their August team meeting); various AECOM sea level rise projects (call scheduled for September); and various SF Bay Conservation and Development Commission (BCDC) projects (call scheduled for September).

We also provided 6 of demonstrations of the Outer Coast decision support tools to the: San Francisco Bay Joint Venture Review Panel for the Bolinas Lagoon Restoration Project Locally Preferred Plan; South Bay Salt Pond Restoration Project staff; Gulf of the Farallones National Marine Sanctuary staff; OCOF Advisory Committee; participants in the Ecosystem-Based Management Tools Network (EBM Tools)-hosted training webinar; participants in the OCOF-hosted training webinar. In addition, we organized a directed training for State Coastal Conservancy (SCC) staff that consisted of: background presentations on the overall OCOF project and CoSMoS; live demonstration of OCOF tools suited to staff's interest; and a discussion including suggestions for future updates, how the tool can best adapted to San Francisco Bay, the SCC project evaluation process and how these tools could be incorporated into it, and the current status/next steps for SCC Central and Northern California coastal assessments and if there is potential for future application/expansion of the OCOF tool to help inform these projects.

What did you learn? Have there been any unanticipated challenges or opportunities?
Timing is crucial. As we have turned attention to providing technical assistance to real-world projects that need to understand risks associated with sea level rise and storm hazards, the OCOF team and intended users have realized how critical having the right information, in the right format, at the right time can be. Several of the projects that we had originally considered prime candidates for OCOF end use are actually not able to apply the tool to their planning process during the period of this grant due to unexpected delays or other alterations to their existing workflows. At the same time, we have identified a number of other potential projects and partners that we hadn't been aware of at the time of our grant writing. At the National Adaptation Forum held in April in Denver, Colorado, OCOF team members were able to discuss what we're learning about the importance of timing and workflows with other tool developers and adaptation practitioners.

We have discovered new projects that are keenly interested in our models for San Francisco Bay. Silicon Valley 2.0 is pulling together the best data available for Santa Clara County and developing a county-wide adaptation plan, as well as plans for local jurisdictions. Again, timing is crucial, as we are working to have the results available to form the basis for the sea level rise information of that plan.

Who has been involved?
The entire team has been involved in various outreach, integration, and technical assistance activities.

Has interaction with intended users brought about any changes to your methods for integration of intended users, the intended users involved, or your project objectives?
We designed a collaborative process that requires input at several key points in the project in order to move forward. During this reporting period, we have not encountered any unanticipated "changes" to our methods or objectives as a result of our interactions with intended users, but we have reached several collaborative decision points, which help to ensure that we build a product that our intended users find useful.

One example of these collaborative decision points is "nested grids". The OCOF Advisory Committee has been asked to help identify and select areas around the San Francisco Bay where "nested grids" (areas of higher resolution data) will be incorporated into the OCOF tool. Whereas most of the Bay model will make explicit predictions every 100m, in areas with nested grids, predictions are made every ~20 meters. We will be able to include approximately 12 nested grids up to 10km in size. During a previous Advisory Committee meeting, we discussed how nested grids were relevant to the project and the planning processes of committee members, and developed selection criteria for choosing sites. Between meetings, we researched Advisory Committee nominations in order to make a joint decision. This is one example of how intended user input shapes our product.

How do you anticipate working with intended users in the next six months?
In the next six months, we will continue to work with our Advisory Committee on decisions related to model scenarios and DST functionality. We will also finalize a framework for the technical assistance program to help managers incorporate the tool into their planning processes, as well as a list of 2-5 technical assistance projects that we will begin to work on with the intended user groups. We will continue to provide demonstrations and directed trainings for the Outer Coast decision support tools, with directed trainings targeted with California Coastal Commission and National Park Service staff, as well as Marin County staff and board of supervisors in Fall 2013.

C. Progress on project objectives for this reporting period:

Describe progress on tasks related to project objectives for this reporting period.

Hold Project Team meetings: Proceeded as planned. Team meetings were held on March 28, May 23, and July 11, 2013.

March 23, 2013 – Brainstormed Technical Assistance Program; discussed potential project expansion to new geographic areas and the need to also seek funds to continue technical assistance, keep the tools current, and expand the forum functionality; planned for April Advisory Committee meeting; SF Bay Modeling update.

May 23, 2013 – Discussed directed trainings and Technical Assistance Program; SF Bay modeling and tool development; ongoing project expansion discussion; debriefed on April Advisory Committee meeting and planned for July Advisory Committee meeting.

July 11, 2013 – Discussed Marin County proposal and budget; directed trainings and Technical Assistance Program; reviewed master spreadsheet created to track technical assistance and funding opportunities; reviewed agenda for upcoming State Coastal Conservancy directed training; ongoing project expansion discussion; planned for September Advisory Committee meeting.

Hold Training Webinars for Outer Coast Decision Support Tools: Proceeded as planned. Two trainings webinars were held on March 26th and April 23rd with 100 attendees total on the use of the decision support tools. These included background information on the project, a live demonstration of the online tools, and a question and answer session. One webinar was hosted through the EBM Tools Network and had attendees from 23 states and 11 countries.

Hold San Francisco Bay Advisory Committee meetings: Modification made. One of two planned Advisory Committee meetings was held on April 18, 2013. See above for meeting details. Feedback about the content and format of meetings has so far been very positive. The scheduled July meeting was not held because team members determined it would be most effective to have one-on-one conversations with Advisory Committee members to discuss the specific project ideas they had given us to be considered for Technical Assistance.

Produce the San Francisco Bay Digital Elevation Model (DEM): Modification made to public release. USGS Earth Resources Observation and Science (EROS) Data Center completed the Digital Elevation Model (DEM) for the entire San Francisco Bay area using all recently collected multibeam bathymetry and topographic LiDAR. The DEM is going through final peer review and is now available by request to PI-Barnard, with the final public version to be made available shortly.

Predict physical climate change impacts from scenarios: Modification made to nested grid time line. Interacted with our colleagues in the region to develop the best approach for integrating fluvial discharge rates and the completed vertical land motion rates in our DEM . Spatially downscaled winds derived from 21st century global climate models have been identified and obtained. A methodology for temporal downscaling of this data has been developed and is currently being applied to generate full time-series (years 2010 through 2100) of 3-hourly winds at a scale of 4km throughout the San Francisco Bay region. High resolution hydrodynamic flow and wave grids are being developed; this includes

construction, sensitivity testing, calibration and validation where possible. When completed , production runs of projected relative sea level rise and storm scenarios will be run (this fall).

Develop flexible framework for web-based DST; revise as needed: Proceeded as planned. We continued to solicit feedback from the Advisory Committee, as well as through demos and directed trainings, in order to improve the map interface, community of practice, and overall usability of the beta decision support tools as needed. Some of the key feedback we received from our Advisory Committee included:

- Wanting more clarity about the range of the modeling estimates, including better display of minimum/maximum flood extents and a better explanation of uncertainty. The Bay is expected to have more uncertainty in the estimates, and the problems users face in the Bay are more sensitive to smaller changes in estimates, making the clarity of displaying model uncertainty even more important.
- Needing the tool to better communicate what high water means.
- Wanting to understand not only if something floods, but how long it will be flooded for. The amount of time something floods is critical to understanding severity of inundation.
- Wanting the reporting mechanics to work better and more quickly (reports are taking several minutes to generate and you can't tell if it's still working or not).
- Needing to find better ways of integrating the user forum into the tool and facilitate discussion, including finding it more easily, and making it more readily available along with notification of activity to users. People want ways of learning and collaborating together more easily and seamlessly.
- Getting case studies of adaptation strategies documented, and georeferencing them on the mapping interface.

From the feedback we received from users, we redesigned the mechanism and layout of how the user driven reports worked in order to make it more obvious to the user what was happening, to give them better control over how they download the reports, and decreased the time it takes to generate reports. We also changed how the data is presented in the report, switching from a graphical summary of predictions, to a simpler, color-coded tabular layout. This change gives users two keys data dimensions that were difficult to discern from the earlier design: more specificity on predicted flood depth ranges and the relative magnitude of each prediction. This dual approach allows both a quick summary view of the results (color coding) as well as closer examination of specific details (ranges of values).
We also added smaller usability items into the DST. We now include the legend from the map in the report, making the report more usable and a better permanent record. Also, we added some critically important information about known issues in specific scenarios and in specific geographic areas.

Coordinate with relevant national, state and local efforts: Proceeded as planned. Through a NSC "transfer" project, we were able to link this project with similar work being conducted in San Diego through the CURRV project. Staff from CURRV and OCOF projects were able to share information and resources, and although the transfer grant itself has ended, transfer activities continue.

Psaros led an effort with the Bay Area Ecosystems Climate Change Consortium to develop a clearer regional narrative for climate change adaptation actions, and several OCOF staff participated in the kickoff workshop to facilitate a breakout group discussion of communicating SLR impacts and adaptation options by using the tool.

Based on our work on the Outer Coast, as well as the developing work in SF Bay funded here by the NERR, the State Coastal Conservancy has begun to organize funding for the USGS to apply a similar

methodology for the entire Southern California coastline that also includes long-term projections of coastal change in the flooding analysis. This project is scheduled to start later in calendar year 2013, and meant to serve as template for what eventually might be a systematic, state-wide assessment.

What data did you collect?

- Spatially downscaled 21st century climate model winds for the San Francisco Bay area (Multivariate Adaptive Constructed Analogues [MACA] available from University of Idaho).
- 30 years (1975-2004) of hourly surface wind data from five observing stations around San Francisco Bay.

Has your progress in this period brought about any changes to your methods, the integration of intended users, the intended users involved or the project objectives?

No

Have there been any unanticipated challenges, opportunities, or lessons learned?

While not necessarily unanticipated, there are challenges and opportunities presented by the rapidly evolving technology available for use on this project. We are engaged with an ever-growing set of application developers and more examples of decision support tools are made available regularly, so we strike a balance between looking for great examples of things similar to what we are building and making progress internally.

What are your plans for meeting project objectives for the next six months?

The following objectives are scheduled to take place during the next 6 months:

Hold Project Team meetings: Team meetings will be held every other month with webinar capability as needed.

Hold San Francisco Bay Advisory Committee meetings: Upcoming meetings are scheduled for September 17 and late fall 2013. We will continue to use the format of previous meetings: a presentation on an aspect of the OCOF project for which we are seeking input or a decision (see above example regarding nested grids), followed by interactive discussion. Meetings close with an update from a committee member on that organizations' sea level rise-related work.

In depth technical assistance, feedback, and evaluation for outer coast tools: Directed trainings are in the process of being scheduled with the CA Coastal Commission and the National Park Service. We hope to also begin working with Marin County to provide technical assistance for their sea level rise vulnerability assessment if the county secures funding to proceed.

Develop flexible framework for web-based DST; revise as needed: Over the next six months we will continue to solicit feedback from the Advisory Committee and through demos and directed trainings, to improve the map interface, community of practice, and overall usability of the beta decision support tools as needed.

Predict physical climate change impacts from scenarios: Over the coming six months we plan to: complete the temporal downscaling of 21st century winds; develop full climate scenarios for the 21st century; develop, test, calibrate model grids and update the model framework; and begin model production runs.

Finalize Technical Assistance Program and projects: We will finalize a framework for the technical assistance program to help managers incorporate the tool into their planning processes, as well as a list of 2-5 technical assistance projects.

D. Benefit to NERRS and NOAA: List any project-related products, accomplishments, or discoveries that may be of interest to scientists or managers working on similar issues, your peers in the NERRS, or to NOAA. These may include, but are not limited to, workshops, trainings, or webinars; expert speakers; new publications; and new partnerships or key findings related to collaboration or applied science.

During this report period, several team members served as expert speakers at a variety of conferences and meetings. Higgason presented the projected at the National Adaptation Forum in Denver, CO in April 2013, with both Higgason and Psaros representing the project in a variety of networking opportunities. Barnard and Erikson provided three talks related to the OCOF project at the Headwaters to Oceans (H2O) Conference in San Diego, CA in May 2013: The application of the Coastal Storm Modeling System (CoSMoS) in assessing the vulnerability of the California coast to climate change using global climate models; 21st century wave climate along the California Coast; The Our Coast-Our Future decision support tool for climate change adaptation. Barnard also provided two additional talks related to the OCOF project: "Assessing coastal climate change impacts using the Coastal Storm Modeling System (CoSMoS)" at the Workshop on Highways in the Coastal Environment- Assessing Extreme Events, Federal Highway Administration in Sacramento, CA in May 2013, and "Coastal climate change impacts for Southern California" at the State Coastal Conservancy Executive Council Meeting in Sacramento, CA in June 2013. Psaros presented the project as an invited speaker at the Rising Seas Summit in Fort Lauderdale, Florida In June 2013.

In May 2013, Barnard was invited by California State Assemblyman Rich Gordon to speak at the first hearing of the Assembly Select Committee on Sea Level Rise and the California Economy in Sacramento. In addition to briefing the California Legislature on the state-of-the-science of projected climate-change impacts to the California coast, he also highlighted OCOF as an example of how to systematically assess impacts to the coast. He used screenshots from the tool to demonstrate the flooding difference considering sea level rise with and without storms, and advised that such a statewide assessment is the next step to fully understand the economic impact of Climate Change. Feedback was very positive, with committee members seeming to understand the need for such an approach. Questions included port vulnerability and guidance on developing state sea level policy that filters down to the local level.

In July 2013, Psaros organized a San Francisco Planning and Urban Research Association (SPUR) Forum, "Preparing for Floods and Sea Level Rise in the Bay Area," with over 100 attendees. Higgason served as a panelist representing the OCOF project with additional panelists including representatives from FEMA Region 9 California Coastal Analysis and Mapping Project, NOAA's Sea Level Rise Viewer, and the California King Tides Initiative. A networking reception was followed by a moderated discussion to explore how these projects are helping cities plan for the future impacts of sea level rise and flooding, and concluded with an opportunity for attendees to test the planning and communication tools.

E. **Describe any activities, products, accomplishments, or obstacles not addressed in other sections of this report that you feel are important for the Science Collaborative to know.**

These have been adequately addressed in other sections of the report.